From products to processes: Academic events to foster interdisciplinary and iterative dialogue in a changing climate

Addor, Nans ; Ewen, Tracy ; Johnson, Leigh ; Cöltekin, Arzu ; Derungs, Curdin ; Muccione, Veruska

Abstract: In the context of climate change, both climate researchers and decision makers deal with uncertainties, but these uncertainties differ in fundamental ways. They stem from different sources, cover different temporal and spatial scales, might or might not be reducible or quantifiable, and are generally difficult to characterize and communicate. Hence, a mutual understanding between current and future climate researchers and decision makers must evolve for adaptation strategies and planning to progress. Iterative two-way dialogue can help to improve the decision making process by bridging current top-down and bottom-up approaches. One way to cultivate such interactions is by providing venues for these actors to interact and exchange on the uncertainties they face. We use a workshop-seminar series involving academic researchers, students, and decision makers as an opportunity to put this idea into practice and evaluate it. Seminars, case studies, and a round table allowed participants to reflect upon and experiment with uncertainties. An opinion survey conducted before and after the workshop-seminar series allowed us to qualitatively evaluate its influence on the participants. We find that the event stimulated new perspectives on research products and communication processes, and we suggest that similar events may ultimately contribute to the midterm goal of improving support for decision making in a changing climate. Therefore, we recommend integrating bridging events into university curriculum to foster interdisciplinary and iterative dialogue among researchers, decision makers, and students.

DOI: https://doi.org/10.1002/2015EF000303

Earth's Future

Supporting Information for

From products to processes: Academic events to foster interdisciplinary and iterative dialogue in a changing climate

Nans Addor[1], Tracy Ewen[1], Leigh Johnson[1], Arzu Çöltekin[1], Curdin Derungs[1], and Veruska Muccione[1]

[1]Department of Geography, University of Zurich, Zurich, Switzerland

Contents of this file

Introduction

This document provides further information on the workshop-seminar series "Uncertainty in Decision Making in a Changing Climate" organized at the University of Zurich:

- Timeline of the workshop-seminar series (Figure S1)
- Description of its key components (Text S1 to S5 and Figure S2)
- Recommendations for future similar events (Text S6)
- References

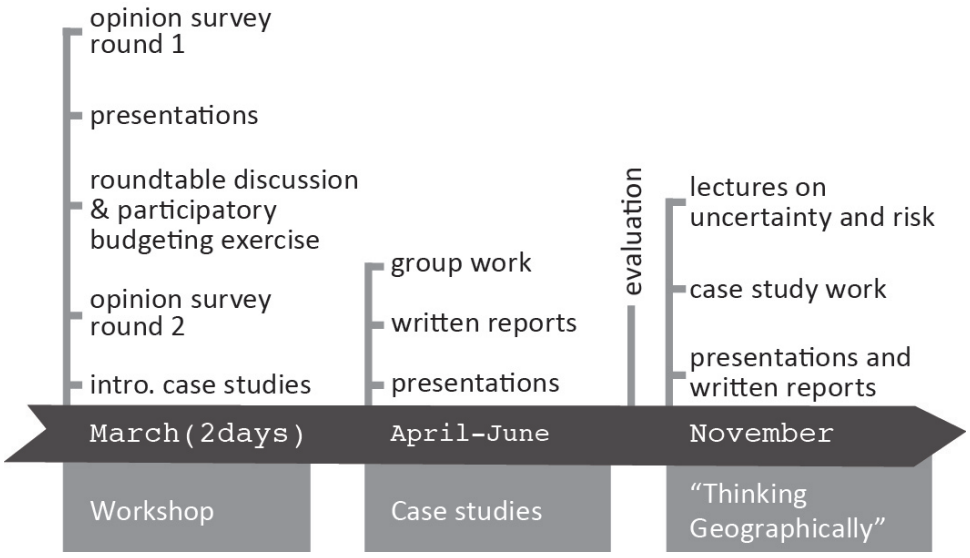

Figure S1. Overview of the components of the workshop, case study seminar and incorporation into a mandatory master's course for geography students entitled "Thinking Geographically".

Text S1. Presentations

With presentations during the workshop, speakers introduced participants to the following topics:

1. Sources and types of uncertainties, including an uncertainty taxonomy (Fisher, 1999).
2. Uncertainty in climate models and scenarios (Deser et al., 2012; Knutti and Sedláček, 2012; Knutti et al., 2013).
3. Visualizing uncertain information (MacEachren, 1992).
4. The social and political frameworks governing adaptation to future flooding in England (Demeritt et al., 2007).
5. Uncertainties in hydrological projections and their implications for water resource management, with a focus on developing more robust adaptation strategies (Wilby and Dessai, 2010).
6. Managing uncertainties and contradictory information in development cooperation (SDC Swiss Agency for Development and Cooperation, 2012).
7. Methods for handling uncertainty and climate risk in the reinsurance sector (Swiss Reinsurance, 2012).
8. The World Food Programme perspective on assessing uncertainty and risk relating to food security (Hazell et al., 2010; World Food Programme and Oxfam America, 2013).
9. Holistic assessment of vulnerabilities and adaptation measures in development cooperation (Clot, 2008; IISD, 2012).

Text S2. Structure and evaluation of the opinion survey

To assess the influence of the workshop on participants' perspectives on exchanges between scientists and decision makers, we conducted an opinion survey before and after the workshop. Participants were asked "What information and tools should be exchanged between researchers and decision makers to better address uncertainty?". Anonymous responses were solicited from all workshop participants (including the invited speakers) at the beginning of day 1 (round 1, Figure S1) and again at the conclusion of day 2 (round 2) using index cards with unique identifiers. To analyze patterns among responses and detect changes over the course of the workshop, responses were digitized and coded for content.

Content analysis via coding is regularly employed in qualitative data analysis in social science and education research (Corbin and Strauss, 2008). Codes are researcher-generated constructs of a few words that distill concepts appearing in individual pieces of language-based data for the purpose of detecting patterns, creating categories, and building theory (Saldaña, 2013). In this case, coding was conducted by two collaborating individuals in two cycles using the qualitative data analysis software Atlas.ti. Initial or "open" coding identified the discrete conceptual categories and relationships evidenced in the responses, followed by focused coding that grouped and refined initial codes based on their frequency and significance (Saldaña, 2013). From a total of 95 responses (53 pre-workshop and 42 post-workshop), we derived 57 codes. A simple frequency analysis allowed us to derive the code's relative frequency across the entirety of responses and to see whether this changed from round 1 to round 2. Codes with a relative frequency ≥ 0.10 in each round of responses were then selected for visualization.

Text S3. Funding options for the mock budgetary exercise

For the mock budgetary exercise, each person was given three sticky notes marked "1", "2", and "3", and asked to rank their funding priorities. The proposals were the following and the participants' votes are summarized in Figure S2:

1. Invest in computational capacity and basic science to generate better climate models, and thus better predictions and understanding, which can then inform decision makers and other users.
2. Invest in instrumentation and data management to produce better, and more, observations.
3. Explore the potential of local knowledge and "uncertified" expertise, prioritizing simplicity over sophistication.
4. Invest in better and more frequent communication, communication tools, and institutionalized forums; promote transparency of scientific assessments.
5. Facilitate dialogues at the science-practice interface to identify research questions and share findings.
6. Use the scientific risk assessment tools and principles of insurance to assess and manage risks in the face of uncertainty.
7. Rather than focusing on uncertain future climate change impacts, invest in adaptation to extreme weather now.
8. Prioritize tools for sustainable development that reduce vulnerability through horizontal learning between communities rather than external technical solutions.

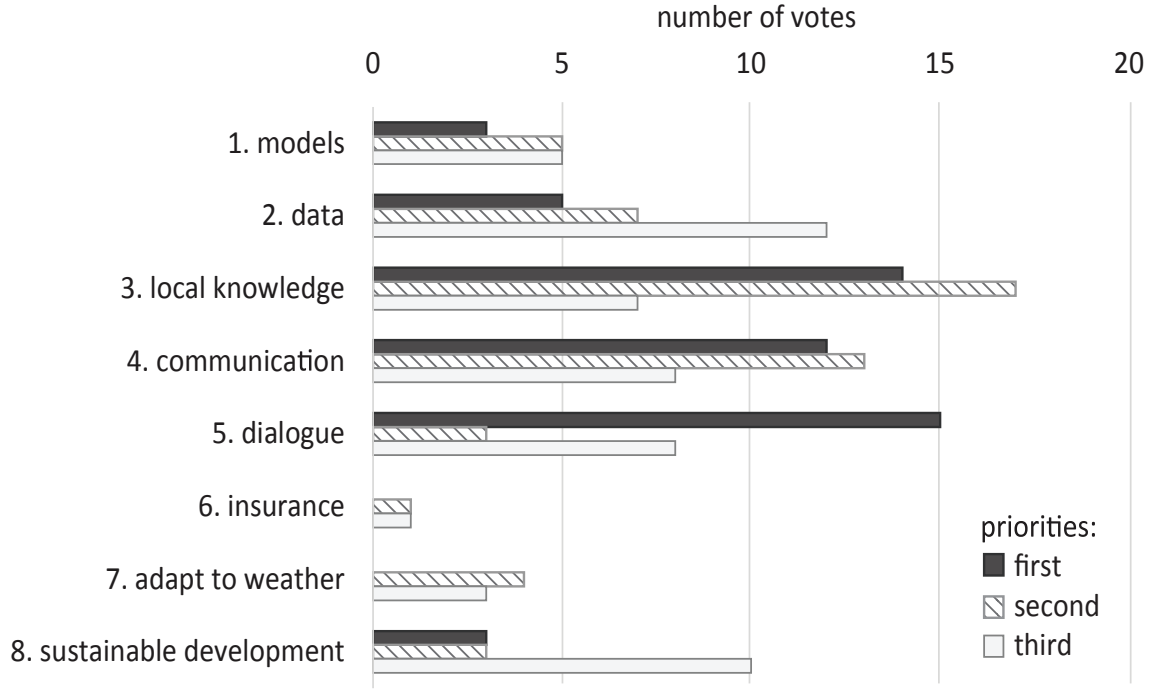

Figure S2. Summary of options to allocate hypothetical grant money, with participants' top three hypothetical budget priorities (with first priority votes indicated in solid dark gray, second priority votes with gray diagonal lines and third priority votes in solid light gray).

Text S4. Case studies: exploring uncertainties in applied research

Following the workshop's expert presentations and roundtable discussion, students were broken into teams and assigned an extended real-world case study developed in collaboration with practitioners, many of whom were invited workshop speakers. The case studies required students from different subdisciplines of geography (geographic information science, remote sensing, physical geography, and human geography) to work in teams with members from bachelor to doctoral levels over a two-month period to identify and describe uncertainties for five applied cases, and further think about how these might influence or be incorporated into the decision making process. Teams then presented their findings to each other in a one-day seminar.

The five case studies were developed based on both in-house expertise and on-going projects that would allow for an analysis of uncertainties by the students and facilitate discussion about the decision making process. The case studies dealt with the uncertainties in:

1. a landslide early warning system in Colombia (Huggel et al., 2010),
2. the implemention of biochar technology in sugar cane farms in southern India (Singh et al., 2012),
3. flood forecasting and management for the city of Zurich (Demeritt et al., 2007; Addor et al., 2011), and
4. an adaptation and microinsurance project for food security in Ethiopia (World Food Programme and Oxfam America, 2013).

The fifth case study investigated the visualization of uncertainties for decision making (MacEachren et al., 2005; Kleiner, 2013). Students looked critically at the visual depiction of uncertainties through a defined user experiment in order to understand how visualization choices influence a decision maker's perspective and the decision taken. The group developed an online survey that presented participants with two comparable visualizations, with one having no representation of uncertainty, and the other having some form of uncertainty representation. The results from this case study were incorporated into a master's thesis on this topic (Kleiner, 2013). Thinking about visualization and communication of results was an particularly useful exercise for students and one that could be developed into a more in-depth seminar or course module.

We found it important to provide the participants with concrete tools to deal with uncertainty. This is in particular supported by the following example. The case study that looked at implementing biochar technology in India came up with four different categories of uncertainties including those related to the production method (methodic uncertainties); the properties of biochar and its interaction with the agroecological system (environmental uncertainties); cost-benefit uncertainties (economic uncertainties); and uncertainties related to whether farmers would accept or "like it" enough to actually implement the technology in their sugar cane farms (social uncertainties). Although identification of these uncertainties was a useful exercise, participants had difficulties thinking about what types of decision makers might use this information and how they might further be incorporated into decisions made.

Text S5. "Thinking Geographically": incorporation of workshop elements into the curriculum

Building on the workshop case studies and feedback, we incorporated some of the material into an already-existing course within the department's master's curriculum called "Thinking Geographically". Three short lectures drew on material from the workshop, providing perspectives from physical, social, and geographic information sciences as well as top-down versus bottom-up approaches for assessing impacts and approaching adaptation. Students in the course then went on to work on case studies again in teams, with a focus this time on broader topics. In comparison with the case studies linked to the workshop, these less narrowly defined cases encouraged more exploratory discussion within the groups about risks and potential uncertainties within decision making processes, especially related to more qualitative aspects stemming from the human geography perspective, and more critical reflection on the methodology applied for risk assessment and management.

Text S6. What are the key elements for productive dialogue-generating academic events?

i. Create an interdisciplinary environment. Feedback for the two-day workshop was very positive, with two thirds of the participants rating it as "very successful" in fostering cross-disciplinary learning and discussion. The speakers commented among themselves on how few occasions they normally have to exchange on their experiences on dealing with uncertainties. The students also found that the workshop's different format from ordinary lectures encouraged them to talk freely and raise questions, but thought the two-day format was too brief. Three months after the workshop, many physical geography students reported that they had found new motivation to integrate human geography and development studies into their curriculum. Professors attending the workshop also found new inspiration, and incorporated elements of the workshop into their classes.

ii. Keep case studies manageable. Although the students praised the multi-level teams of bachelor, master, and PhD groups formed to work on case studies, two thirds rated them only "somewhat successful". This average evaluation likely reflects the fact that the participants were given quite difficult tasks related to their case studies in comparison to the more positively evaluated workshop, in which they listened to engaging presentations from speakers. The difficulties they had with the case study exercises nevertheless congruously emphasized the real-world difficulty in addressing such challenging and interdisciplinary issues. Indeed, the difficulty in carrying out the tasks in the case studies also reflects the barriers to introducing interdisciplinary climate change issues into curriculum (Davison et al., 2014).

iii. Provide concrete methods to deal with uncertainty. Although participants found case studies to be a useful exercise, many wished for more concrete decision making scenarios and analytical tools that could have been used and applied within the case studies (see the example in Text S4). Overall, if the workshop were to be organized again, our main recommendation would be to familiarize participants with concrete technical methods to facilitate decision making in the face of uncertainty. For instance, for the case studies, the participants could establish, possibly in a simplified way, the vulnerabilities of a community or

infrastructure, and would then be provided with some uncertain climate information that they would assess and use to explore future risks (see e.g., the visuals in Brown and Wilby, 2012) and make recommendations. They could then be given a complementary set of climate data, such as simulations from the latest climate models, to introduce the importance of flexible adaptation frameworks.

References

Addor, N., Jaun, S., Fundel, F. and Zappa, M. (2011), An operational hydrological ensemble prediction system for the city of Zurich (Switzerland): skill, case studies and scenarios, *Hydrol. Earth Syst. Sc.*, *15*, 2327–2347, doi:10.5194/hess-15-2327-2011.

Brown, C., and R. Wilby (2012), An alternate approach to assessing climate risks, *Eos Trans. AGU*, *92(41)*, 92–94, doi:10.1029/2012EO410001.

Clot, N. (2008), Highlighting local coping strategies for drought, in Integrating Disaster Risk Reduction into Climate Change Adaptation, UN/ISDR Gender Perspective.

Corbin, J. and Strauss, A. (2008), Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, Sage Publications.

Davison, A., Brown, P., Pharo, E., Warr, K., McGregor, H., Terkes, S., Boyd, D. and Abuodha, P. (2014), Distributed leadership: Building capacity for interdisciplinary climate change teaching at four universities, *Int. J. Sustain. High. Educ.*, *15(1)*, 98–110, doi:10.1108/IJSHE-10-2012-0091.

Demeritt, D., Cloke, H., Pappenberger, F., Thielen, J., Bartholmes, J. and Ramos, M. (2007), Ensemble predictions and perceptions of risk, uncertainty, and error in flood forecasting, *Environ. Hazards*, *7(2)*, 115–127, doi:10.1016/j.envhaz.2007.05.001.

Deser, C., Knutti, R., Solomon, S. and Phillips, A. S. (2012), Communication of the role of natural variability in future North American climate, *Nat. Clim. Change*, *2(11)*, 775–779, doi:10.1038/nclimate1562.

Fisher, P. (1999), Models of uncertainty in spatial data, in Geographical Information Systems: Principles and Technical Issues, edited by P. A. Longley, M. F. Goodchild, and D. J. Maguire, pp. 191–205, John Wiley, New York.

Hazell, P., Anderson, J., Balzer, N., Hastrup Clemmensen, A., Hess, U. and Rispoli, F. (2010), The Potential for Scale and Sustainability The Potential for Scale and Sustainability in Weather Index Insurance.

Huggel, C., Khabarov, N., Obersteiner, M. and Ramírez, J. M. (2010), Implementation and integrated numerical modeling of a landslide early warning system: a pilot study in Colombia, *Nat. Hazards*, *52(2)*, 501–518, doi:10.1007/s11069-009-9393-0.

IISD (2012), CRiSTAL User's Manual Version 5 Community-based Risk Screening Tool – Adaptation and Livelihoods, The International Institute for Sustainable Development.

Kleiner, J. (2013), Uncertainty communication - The use of visualisations to provide uncertainty information, 95 pp., Master Thesis, University of Zurich, Zurich, Switzerland.

Knutti, R., Masson, D. and Gettelman, A. (2013), Climate model genealogy: Generation CMIP5 and how we got there, *Geophys. Res. Lett.*, *40(6)*, 1194–1199, doi:10.1002/grl.50256.

Knutti, R. and Sedláček, J. (2012), Robustness and uncertainties in the new CMIP5 climate model projections, *Nat. Clim. Change*, *3*, 369-373, doi:10.1038/nclimate1716.

MacEachren, A. M. (1992), Visualizing uncertain information, *Cartogr. Perspect.*, *(13)*, 10–19.

MacEachren, A. M., Robinson, A., Hopper, S., Gardner, S., Murray, R., Gahegan, M. and Hetzler, E. (2005), Visualizing Geospatial Information Uncertainty: What We Know and What We Need to Know, *Cartogr. Geogr. Inf. Sci.*, *32(3)*, 139–160, doi:10.1559/1523040054738936.

Saldaña, J. (2013), The Coding Manual for Qualitative Researchers, 2nd Ed., Sage Publications, London, UK.

SDC Swiss Agency for Development and Cooperation (2012), CEDRIG: Climate, Environment and Disaster Risk Reduction Integration Guidance, Part II CEDRIG Handbook, Berne, Switzerland.

Singh, N., Abiven, S., Torn, M. S. and Schmidt, M. W. I. (2012), Fire-derived organic carbon in soil turns over on a centennial scale, *Biogeosciences*, *9(8)*, 2847–2857, doi:10.5194/bg-9-2847-2012.

Swiss Reinsurance (2012), Weathering climate change: Insurance solutions for more resilient communities, Swiss Re, Zurich, Switzerland.

Wilby, R. L., and S. Dessai (2010), Robust adaptation to climate change, *Weather*, *65(7)*, 180–185, doi:10.1002/wea.543.

World Food Programme and Oxfam America (2013), R4 Rural Resilience Initiative Quarterly Report.